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A review of research literature revealed that some researchers felt that the use of colored rods, such as the Cuisenaire materials, in teaching number work gave perceptual support to many relationships. Experiments conducted over 3 years attempted to test some of these relationships. During each year, experimental classes in grade one were receiving Cuisenaire instruction while control groups were not. Each ensuing year, classes in grade two and then grade three were included in the experiments. The results from standardized tests and teachers' questionnaires led to the following conclusions: (1) children taught with Cuisenaire materials gained facility in manipulating whole numbers and fractions as shown on a Cuisenaire test; (2) Cuisenaire materials were more effective with bright children; (3) children who used Cuisenaire materials for 2 years scored higher than those using them for 1 year, and they in turn scored higher than the control groups; (4) first grade classes benefited more from the materials than second grade class; and (5) teachers and consultants were enthusiastic about the value of the materials. An extensive bibliography is appended. (JS)

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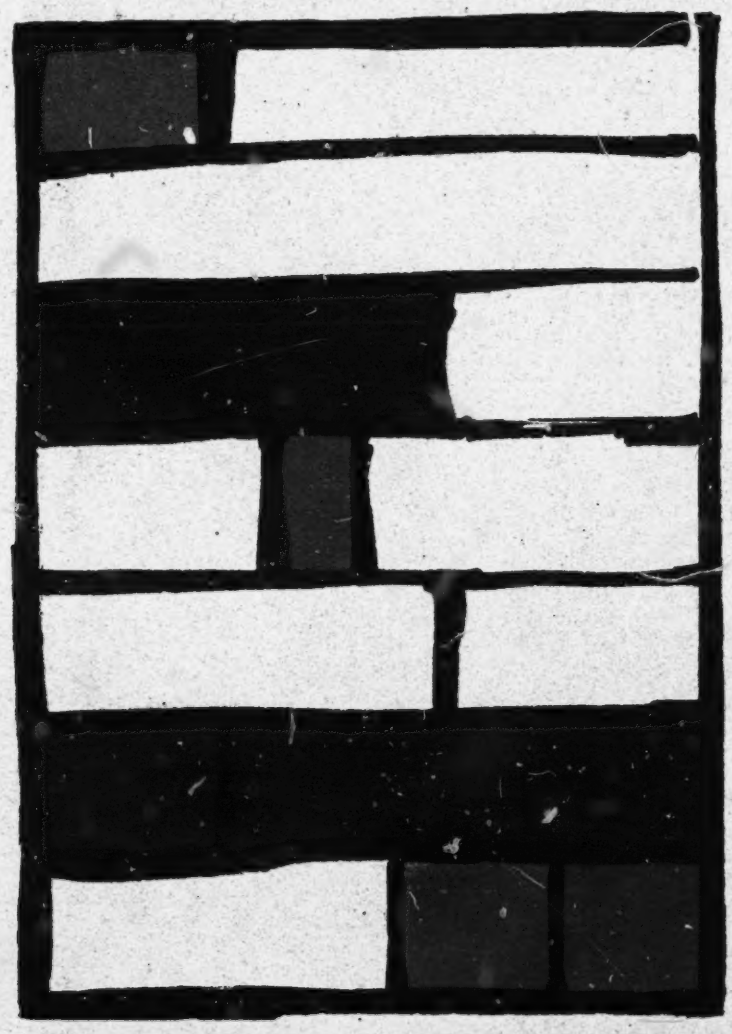

THE USE OF COLOURED RODS

IN PRIMARY NUMBER WORK.

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THE USE OF COLOURED RODS

IN TEACHING

PRIMARY NUMBERWORK

FOREWORD

Teachers of arithmetic are currently paying increasing attention to the methods and materials of instruction so that pupils in the elementary schools today may be better prepared for the technological world of tomorrow. The focus of this attention is properly at the primary level where numberwork foundations are laid for the arithmetic that supports the pillars and superstructures of higher mathematics.

It is at this level that many new manipulative materials are being introduced. Among the more promising of these is a rational and coherent system of instruction employing coloured rods. This report on the use of these rods includes:

(1) a review of the literature and related research,
(2) a summary of experiments with coloured rods, and
(3) a description of recent developments in the Modern Arithmetic programme in Vancouver schools.

The reader is reminded that experimental research is often unable to tell the whole story. Much that we teach cannot be tested, and this is also true with coloured rods. We are unable to measure satisfactorily the child's attitude toward arithmetic or his real understanding of the number system. Some who have followed the experiments believe that it is in this area that the coloured rods make their greatest contribution. When these materials are employed by skilful and imaginative teachers, the rote memorization of number facts becomes replaced by exploration, discovery, understanding, and insight. Also disappearing is the frustration of persistent failure as more pupils achieve an acceptable level of competence in numberwork. Most children find manipulative materials attractive; pupils in Vancouver appear to be deriving pleasure and satisfaction in their use of the rods. The accompanying pictures serve to illustrate complete preoccupation of children with the rods. There can be little doubt about their motivational value. Some teachers believe, too, that these materials help to develop desirable attitudes toward arithmetic.

Accordingly, in the interpretation of this report the reader should keep in mind that apart from gains in achievement, there may accrue other benefits that do not lend themselves to statistical analysis. Qualitative observations of these effects should supplement the conclusions drawn from controlled experiments. It may be that we shall have to wait until our pupils have completed the elementary grades to see how well these benefits persist. Only then can the long-term effects be properly evaluated.

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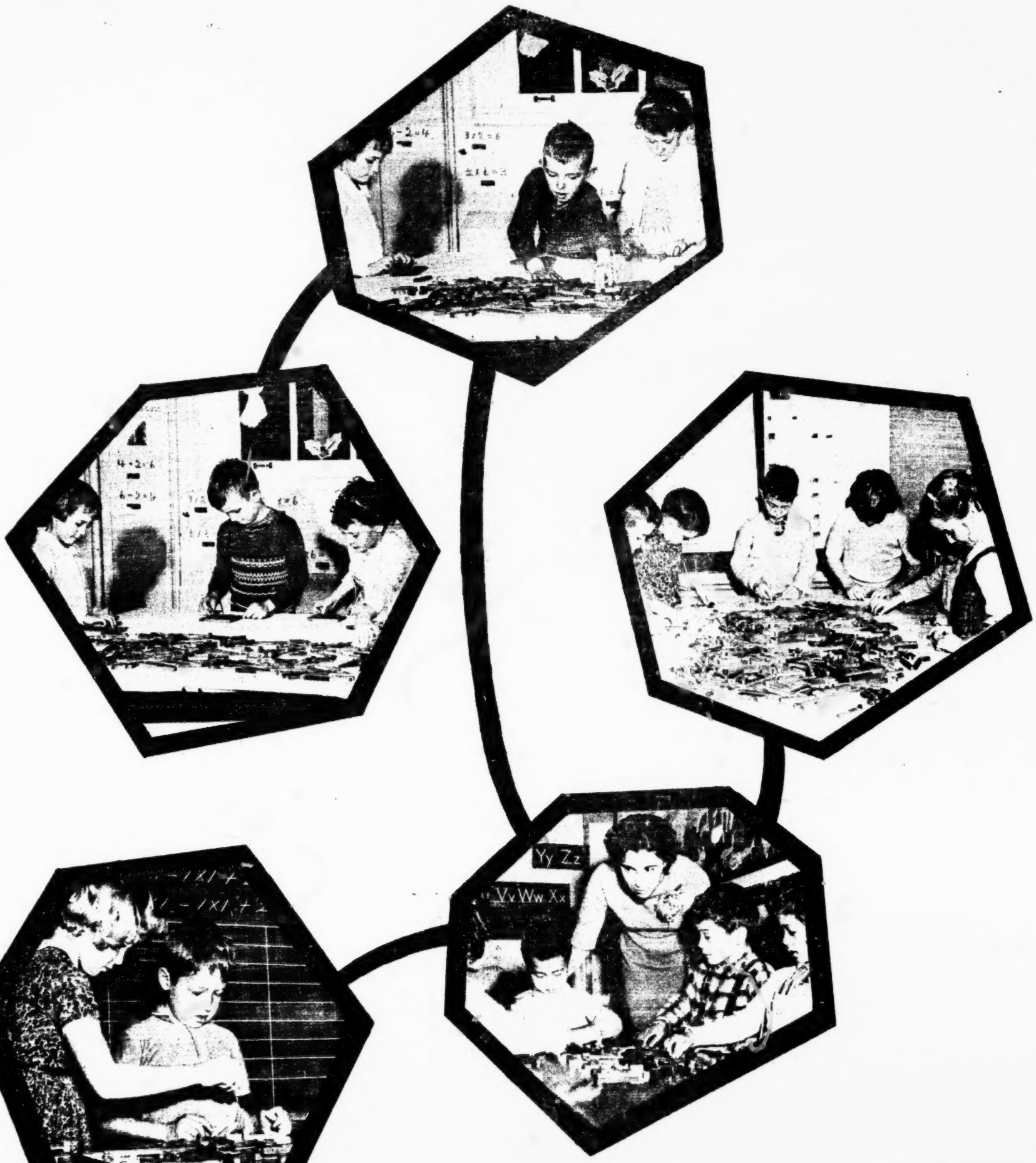

THE USE OF COLOURED RODS IN PRIMARY NUMBER WORK

THE USE OF COLOURED RODS * IN TEACHING PRIMARY NUMBERWORK

Introduction

Educators in all parts of the world are currently re-assessing the effectiveness of arithmetic instruction in the primary grades. They are directing attention both to the content and to the method of teaching numberwork.

The content of arithmetic is being up-dated to meet the increasing demands of the space age. In America, many study groups (79, pp. 2-8), often supported by foundation funds, are attempting to develop suitable programmes of studies that will offer the pupil of the primary grades exciting adventures into mathematics. The University of Illinois Arithmetic Project (79, p. 2) has demonstrated that young children have an aptitude for learning sophisticated mathematical concepts. At Stanford (79, pp. 3-4), set theory and elementary geometry have been taught to pupils in the first grade. The Madison Project (79, p. 7)has produced a two-year programme in algebra suitable for presentation to children as early as Grade 3. At higher grade levels programmes such as these are even more numerous. These experiments provide evidence that children can assimilate mathematic principles at an early age.

The methodology of arithmetic instruction is also receiving much attention. The contributions of Piaget (69, 70; 2, 17, 53, 54, 60, 81) to the psychology of learning and the findings of other research workers (4,13, 25, 41, 48, 61, 75, 90) suggest that the immediate goal of early number teaching should be "understanding". Meaningful teaching is more likely to achieve this aim than mechanical drilling. Teaching for understanding is rapidly replacing meaningless drill. Appropriate number games and mathematically sound concrete materials are being used more extensively in kindergartens and in the primary grades. It is to one of these materials, Cuisenaire rods, that the present study will direct the reader's attention.

The Cuisenaire Materials

The Cuisenaire materials (18, 19, 31, 32, 33, 37, 40) consist of rectangular wooden rods having a cross-section of one square centimeter and ranging in length from one to ten centimeters. The rods are stained in ten different colours, the rods of one colour being equal in length to one another and different in length from those of other colours. Colour enhances the attractiveness of the rods. It facilitates rapid identification, for each colour becomes associated with a number-value and size value. In the design of the rods, both ordination and cardination are taken into account. Numbers and their multiples are represented by related colours and this helps children to understand number and size relationships. Thus dimension and colour constitute a double link between numbers.

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* In the Vancouver experiment, Cuisenaire rods were used as recommended in the Gattegno-Cuisenaire manuals. These have been supplemented in recent years by other materials and techniques in Modern Mathematics that are currently being developed in various parts of the world. Accordingly, the primary numberwork programme in Vancouver schools is presently referred to by the name "Modern Arithmetic" (see "Recent Developments in Vancouver", pages 15-17.)

There are three supplementary aids; a wall chart, product cards, and a Lotto game. These may be used to gain practice in rapid calculation and to ensure that the perception of products and factors become second nature to the child.

Mr. Cuisenaire first constructed the materials in Belgium more than thirty years ago to help his pupils to understand basic number concepts. The use of Cuisenaire rods has since spread to other countries of Europe, to America, and to Australia. The first instruction booklets were published in 1952.

In its present form, the Cuisenaire method aims to develop an understanding of our number system, and an insight into number relationships. The most significant feature of the method is that the child employs several sense modalities to discover number relationships. In using the coloured rods, seeing is associated with feeling, doing, understanding, reckoning, and checking, and therein lies their greatest value. They serve to provide the child with a vivid mental image of each number relationship. The rods involve the active use of eyes and hands. The tactile sense is brought into play when the child identifies the rods by feel. Doing satisfies a need for action. It provides an outlet in the spontaneous construction of numerous combinations freely discovered by the child and based on his awareness of relationships and groupings of numbers. Action also provides the opportunity for finding answers to specific problems formulated by the teacher and leads to understanding and retention of basic number relationships. Through the manipulation of the rods, the child discovers new combinations and increases his skill in calculating. Furthermore, he uses the rods to check his results. This verification is an important facet of the child's growing power in arithmetic. He soon learns to rely on his own criteria for correcting his mistakes. Every child needs to experience success, and the Cuisenaire System effectively minimizes failure; herein lies a significant psychological advantage of Cuisenaire materials.

Review of the Literature and Related Research

The work of the Swiss psychologist, Piaget, (69, 70) probably provides the most potentially fruitful source of relevant theory relating to the development of number concepts in children. He suggests that these concepts are formed as a result of "action experience" building up mental structures that serve as a reference system for the interpretation of direct sensory experience. Piaget distinguishes several stages of intellectual development and these have been well illustrated in a study by Churchill (13).

Biggs (4) summarizes research findings on the development of number concepts in young children. He describes the controversy that has raged for the past twenty-five years between advocates of the "mechanical" and the "meaningful" approaches to arithmetic instruction. He presents evidence that supports both approaches and concludes:

"If speed in a highly specialized task is the aim of teaching, the drill or mechanical method is likely to be superior; if, however, the children are required to transfer their knowledge and skill to new situations, the meaning method is much to be preferred.

Mechanical training may be more effective if the skill is required immediately after the training period, but if the skill is meant to be at all enduring, meaningful teaching is almost a 'sine qua non'.

When dealing with more complicated material and more difficult concepts, the meaning method is essential. However, with children of low intelligence, the meaning method may be too difficult to apply: in which case (if the skill in question must be mastered) one would have to fall back on the rule method.

There is some evidence to the effect that children like to be taught meaningfully -- although it must not be forgotten that the rote learning of material and the calculation of large numbers of drill sums can be a source of pleasure to children. The pleasure, however, soon palls if the child is continuously at a loss to understand what he is doing -- even if he is getting his sums correct.

It seems, generally, that the most effective method is a combination of both -- the topic should be introduced in a meaningful way, after which a reasonable amount of practice, or drill, is desirable to gain familiarity with the new skill or principle." (4, p. 29).

This general conclusion is supported by Howard (48) who found that when fractions were taught by any of three methods (drill, meaning, meaning followed by drill), there was no immediate difference, but that after a period, retention tests showed a high loss for the first method, less for the second, and no loss at all for the third.

In an analysis of meaning in arithmetic, Van Engen (90) concludes that action-experience is an essential pre-requisite to the development of meaning.

Dienes (25) traces the growth of mathematical concepts in children through experience and shows that with Cuisenaire or Stern materials, concepts can be caused to develop in children so that the techniques they learn are preceded by an understanding of the corrsponding mathematical structures. He states:

"A large majority of normal children can understand the complex workings of the four rules of arithmetic in the decimal and other systems; normal ten year-old children can learn the use of brackets,the properties of squares, the solution of linear and quadratic equations and the factorising of quadratic functions, if approached from the constructive

point of view. In fact, it is possible to give children leaving junior school a solid body of practical experiences, impossible to obtain from real life situations, on which a very extensive secondary school curriculum can be based. There are almost limitless possibilities for enlarging the junior school syllabus, by including such topics as theory of groups, usually reserved for university honours courses.

There is, even now, sufficient evidence to suggest that mathematics can be introduced to a larger section of the child population than has hitherto been thought practicable or possible. This is done by co-ordinating the teacher's work with the natural process of concept formation in the child." (25, p. 28).

Hull (52) discusses some psychological implications of the Cuisenaire approach. He writes:

"Because the rods give perceptual support for a multiplicity of relationships, separate points of view can become integrated at the visual level, and reversible mental operations, to use Piaget's term, soon become commonplace."(52,p.3).

Gattegno (31, 34, 35, 39, 40, 41) adds to the list of psychological advantages of the Cuisenaire method and has prepared a series of text books (32, 33) manuals (37, 40) and a film-strip with notes which outline the Cuisenaire-Gattegno approach to the teaching of arithmetic. Mimeographed exercises and workbooks (89) have been prepared by imaginative teachers. Supplementary suggestions (23) for the use of Cuisenaire materials have been prepared by the Department of Education in Victoria, Australia where Cuisenaire materials have been used on an experimental basis since 1956.

Williams (104) describes some of the "concerete analogues", (Cuisenaire, Stern and Montessori,etc.) presently available in Britain for the teaching of primary numberwork. He provides a detailed comparison of the features and devices used in ten systems of number instruction and lists their sources.

Biggs (5) summarizes the distribution of these methods of instruction in primary schools in England and Wales. As many as one quarter of all the schools in Biggs' survey were using non-traditional methods.

Brownell (9) visited schools in England and Scotland and reported on the prevalence of the newer experimental programmes. He suggests that the attention span of school beginners has been seriously underestimated, that their readiness for arithmetic has been underrated, and that pupils in the primary grades can learn much more in arithmetic than we are now asking them to learn. He raises some important theoretical issues and suggests that the emerging arithmetic programme will call for no wholesale abandonment of materials and methods now in general use. He feels that currently popular systems with minor changes will be entirely adequate for the new arithmetic.

Karatzinas and Renshaw (57) sent a questionnaire to forty teachers in Edinburgh who had started at the Primary I level to use the Cuisenaire material. A majority considered that they were achieving comparatively better results and reported that the children found the rods more attractive than other concrete devices. The researchers matched a group of forty boys who had had eighteen months of experience with the rods with a control group of thirty-eight children who had been taught by traditional methods. When a simple fractions test and sections of the Schonell Diagnostic Arithmetic test were administered, it was found that in the sub-tests completed by both groups (addition and subtraction), the Cuisenaire class had gained a no less effective mastery than the control group. However, the control group had not made sufficient progress to be able to attempt the multiplication, division, and fraction items, whereas the children taught with Cuisenaire materials could solve these items easily.

Howard (49) reports a study of the Cuisenaire-Gattegno colour-rod approach to the teaching of arithmetic, based on observations in twenty-two infant and junior school classes in the London (England) area, and on interviews with thirty-one teachers, as well as on classroom demonstrations by Dr. Gattegno. He concludes that:

> "the Cuisenaire-Gattegno colour-rod approach is valuable and holds promise for further development;"
>
> "although slower learners benefit to some extent from the colour-rod approach, the average and brighter children seemed to benefit to a greater extent;"
>
> "certain mathematical concepts that are not usually developed easily in children by current approaches to arithmetic were facilitated considerably by the use of the material in the recommended manner;" and
>
> "at present the Cuisenaire-Gattegno approach holds considerable promise as a supplement to current methods, and further studies should be made to evaluate its effectiveness and to develop the procedures." (49, p.195).

Kelly (59) raises some doubts in regard to the worth of the method:

> "Although the Cuisenaire materials have become popular in parts of Europe and have made slow gains in the U.S.A., some educators claim that the abstractness of certain reasoning required is more appropriate to the level of the superior student and that the reliance upon colour tends toward over-dependence upon a non-mathematical factor."

Sillitto (21) describes the virtues and the inherent dangers in the use of the Cuisenaire method. He is not convinced that a set of Cuisenaire rods offers better value for the money than a set of weights and scales.

Educators in western Canada have initiated action research with Cuisenaire materials. In Saskatchewan, after a year's trial in a number of schools, The Department of Education and the Saskatchewan Teachers' Federation jointly sponsored a larger and more controlled experiment (46, 72).

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Control groups and experimental groups were set up in Grades I, II and III, and four tests were administered during the year. Average scores on power and special tests were higher for the experimental groups than the control groups. The experimenting teachers were, on the whole, favourable to the Cuisenaire method. They reported that when taught mathematics by the Cuisenaire method, students develop a larger interest span, enjoy their work more, find mathematics easier to learn, and make better progress than by previously used teaching methods (46).

In Manitoba, over eight hundred pupils in Grade I were participating in an experiment with Cuisenaire materials during the 1960-61 school year and the programme is being continued during the present school year. The teachers of these classes are 'of the opinion that children develop more speed and accuracy at an earlier age with this method and are capable of doing more than the present course of study calls for.' (10, p.41).

The Board of School Trustees for West Vancouver (103) sponsored a small scale experiment in the 1957-58 school year. One class of twenty-eight low-ability pupils in Grade I was given an arithmetic readiness test. Twenty of these were in the lowest quartile (D's and E's) in terms of district norms. These pupils were taught with Cuisenaire materials throughout the school year, and in terms of a district arithmetic test given in June, the number of pupils in the lowest quartile was reduced by 35%. On the inventory test given at the same time, the number of pupils in the lowest quartile was reduced by 75%.

The following year the experiment was repeated with a heterogeneous class in Grade I. Twenty-three percent of these pupils were in the top quartile in terms of the arithmetic readiness test. After a year's instruction with Cuisenaire rods, the proportion in the top quartile on the June district arithmetic test and the June inventory test was 87% and 86% respectively.

One test in Cuisenaire arithmetic was given to pupils in Grade II and Grade VI. The Cuisenaire class in Grade II had a higher median score than the traditionally taught class in Grade VI.

An experiment (6) with Cuisenaire materials was conducted in Grade II of Brandon elementary schools. Pupils were divided into three groups; those taught by Cuisenaire in Grade I and Grade II, those taught by Cuisenaire in Grade I but not in Grade II, and those who had no Cuisenaire instruction. A teacher-made power test including addition, subtraction, number relations, fractions, and mixed calculations was given to all three groups. Although the groups were equated in terms of mental ability, pupils with two years of Cuisenaire experience surpassed those who had had only one year, and these in turn did significantly better than those who had no Cuisenaire instruction.

The Royal Commission on Education for the Province of British Columbia (12) in 1960 observed experimental classes using the Cuisenaire method. Visits paid by the Commissioners were unannounced and there was no previous coaching of pupils. Pupils that were observed were not especially chosen for the purpose, but were regular Grade I and Grade II pupils. The following statements from the Report indicate the reactions of the Commissioners:

..... "The teacher wrote long sums on the blackboard....the children answered correctly without hesitation...There was no finger counting...the calculation appeared to be entirely one of mental arithmetic."

> "There seems to be little doubt regarding the value of a method of this sort which provides an interesting way of teaching arithmetical sums and relationships. Another evident factor in the success of the method was the enthusiasm of the teachers and the competent manner in which they were using the materials."
>
> "The Commission considers that the Cuisenaire method justifies careful study and a continuation of the experiments that are being carried out. The Commission recommends that the use of the Cuisenaire method be studied by members of the Faculty of Education of the University of British Columbia, and, if the results indicate superior accomplishment on the part of pupils taught by this method, that courses of instruction in the use of the Cuisenaire method be introduced into the elementary teacher training programme." (12, pp.306-7).

The Vancouver Experiments

In the 1956-57 school year, several teachers in one Vancouver school unofficially experimented with the materials. The results were encouraging, but real proof was lacking. Accordingly, the Vancouver Board of School Trustees authorized a controlled experiment with these materials.

The First Year, 1957-58 -- A Controlled Experiment in Grade I

Early in the fall term of 1957, one "experimental" class and one "control" class were designated in each of five schools, selected so as to be a representative sample of the city. An effort was made to equate teacher ability in choosing the control for each experimental class.

Four sets of Cuisenaire materials were supplied to each of the experimental classes and the experiment got under way early in October. For both the experimental and control classes, instruction was limited to twenty minutes daily; ten minutes teaching followed by ten minutes of "seat work".

The following tests were given to both the experimental and control classes:

1. The Detroit Beginning First-Grade Intelligence Test (Sept., 1957).
2. *An initial survey test in numberwork (Jan., 1958).
3. *A terminal test based on the prescribed course of numberwork for Grade I (June, 1958). The difference between a pupil's score on this test and his score on the initial test was taken as a measure of his gain in number skill. This gain served as the basic criterion of achievement.
4. *(next page).

*The Primary Supervisor and her staff prepared these tests. The Primary Consultants administered them to all of the classes under carefully standardized conditions.

4. *A survey test of the content taught with Cuisenaire materials (June, 1958). Because this test covered material beyond the limits of the Grade I course, such as complex manipulations of whole numbers and fractions, it was not a fair or valid test for the control classes.

TABLE I: MEAN SCORES ON DETROIT TEST, ON TESTS IN GRADE I NUMBERWORK, AND ON CUISENAIRE NUMBERWORK TEST -- VANCOUVER SCHOOLS 1957-58.

Classes	Number of Cases	Mean of Detroit I.Q.'s	Mean Score Init'l Test	Mean Score Final Test	Mean Gain in Basic Number-work	Mean Score Cuisen-aire Test
Control	115	108.2	15.8	26.2	10.4	11.6
Experimental	122	111.1	16.2	27.3	11.1	22.6
Both	237	109.7	16.0	26.8	10.8	17.3
Difference (Experimental-Control		2.9	0.4	1.1	0.7	11.0

From Table I it can be seen that on the basis of performance on the Detroit Test, the experimental groups appeared to have higher mental ability than the control groups. Although the overall differences of 2.9 points is not statistically significant, allowance for this difference was made by an analysis of covariance technique. In terms of the mean gain in scores on tests of basic Grade I numberwork, the experimental groups were superior by 0.7 points. This difference is not statistically significant, when one allows for the difference in mental ability between the two groups. We may conclude that the Cuisenaire classes did not suffer any "set-back" in the basic Grade I numberwork.

In performance on the Cuisenaire test, the mean score for the experimental pupils was 22.6, and for the control pupils, 11.6. The difference between these mean scores is highly significant. We may attribute the superior performance of the experimental classes on the Cuisenaire test to the fact that they were taught with Cuisenaire materials while the control classes were not. Certainly, the experimental classes far surpassed the controls in facility with the more complex manipulations of whole numbers and fractions.

A comparison was made of the relative effectiveness of traditional and Cuisenaire methods with bright pupils and slow pupils. With this criterion (gains in scores on tests of basic numberwork), the results indicated that the effectiveness of a particular method of instruction was independent of the ability of these groups.

In the interpretation of the results of this research, the following limitations should be considered:

1. The restricted length of time for the experiment. It may be that the period for the gains in "basic number skills" was not sufficiently long.

2. The restricted size of the samples.

3. The absence of standardized tests suitable for this research.

4. The difficulty of equating "teacher-ability".

5. The necessary delay for the initial test to enable the pupils to develop an understanding of written symbols in arithmetic.

6. The limited supply of Cuisenaire materials.

7. The possible inequality of motivation. It may be that the attractiveness of Cuisenaire materials heightened the interest of pupils in arithmetic. Furthermore, the mere specialization of procedures and materials for the Cuisenaire classes may have produced a motivational bias in their favour. ("Hawthorne" effect).

8. The restriction of locations of classes.

9. The relative inexperience of the teachers with Cuisenaire materials.

The Second Year, 1958-59 -- A Controlled Experiment in Grade I

One "experimental" and one "control" class in each of eight schools participated in this experiment. The Board supplied each "experimental" class with eight sets of Cuisenaire rods and early in October the teachers began instruction simultaneously. For all classes, daily lessons were limited to twenty minutes: ten minutes of teaching followed by ten minutes of "seat work."

The testing program was the same as that of the previous year, and the results are shown in the following table:

TABLE II: MEAN SCORES ON DETROIT TEST, ON TESTS IN GRADE I NUMBERWORK, AND ON CUISENAIRE NUMBERWORK TEST -- VANCOUVER SCHOOLS 1958-59

Classes	Number of Cases	Mean of Detroit I.Q.'s	Mean Score Init'l Test	Mean Score Final Test	Mean Gain in Basic Number-work	Mean Score Cuisen-aire Test
Control	134	109.1	18.7	27.1	8.4	10.4
Experimental	179	112.0	18.3	27.9	9.6	28.6
Both	363	110.5	18.5	27.5	9.0	19.3
Difference (Experimental-Control)		2.9	- 0.4	0.8	1.2	18.2

From Table II, it will be seen that the experimental group appeared to have slightly higher mental ability and that the experimental group made a slightly larger "mean gain" on the numberwork tests than the control group. An analysis of covariance that made allowance for the initial differences in mental ability between the two groups showed that the slightly larger gain in numberwork achievement made by pupils taught with Cuisenaire materials was not significant and could be attributed to sampling fluctuations rather than to a real treatment effect.

From Table II,it will also be seen that in performance on the Cuisenaire test the mean score (28.6) made by pupils in the experimental groups was much greater than the average score (10.4) made by those in control groups. In all schools, the ratio of these mean scores exceeded 2:1 and in three schools it exceeded 3:1. The superior performance of the "experimental" classes on the Cuisenaire test was due to the fact that they were taught with Cuisenaire materials, while the control classes were not.

A comparison was made of the relative effectiveness of traditional and Cuisenairé methods with bright and with slow pupils.

TABLE III: A COMPARISON OF THE PERFORMANCE OF SLOW* PUPILS AND BRIGHT** PUPILS IN BOTH GROUPS -- GRADE I, VANCOUVER SCHOOLS 1958-59

Category	No.	Treatment Group	Mean I.Q.	Mean Gain Test Score on Basic Numberwork
Bright	32	Experimental	132.5	21.3
Bright	32	Control	130.3	19.4
Slow	32	Experimental	91.6	16.4
Slow	32	Control	88.4	15.9

* Four pupils from each class with the lowest I.Q.'s.
** Four pupils from each class with the highest I.Q.'s.

An analysis of variance revealed that:

1. a highly significant relationship existed between ability and achievement,

2. the difference between the achievements of groups taught by different methods was not significant and,

3. the relative effectiveness of a particular method of instruction (Cuisenaire or traditional) was independent of whether the group was bright or slow. Cuisenaire materials appeared to be the more effective with bright children than with slow children in bringing about a gain in the scores on tests of basic Grade I numberwork.

The Second Year, 1958-59 -- An Experiment in Grade II

The experiment of 1957-58 was extended by the establishment of an "experimental" class in Grade II in each of the same five schools that participated in the previous year. Unfortunately, it was not possible for all of the classes to retain their identities completely and, accordingly, the results of this study should be interpreted conservatively.

Daily lessons in these classes were limited to fifteen minutes of formal instruction and fifteen minutes of seat work. Workbooks were used and all of the content in the prescribed course was covered.

In June the following tests were administered:

1. A standardized test (Metropolitan Achievement Test, Primary II, Form T, Arithmetic Fundamentals and Arithmetic Problems). This test was given not only to the five experimental classes, but also to all of the Grade II classes in each of the five schools so that a comparison might be made between the Cuisenaire classes and others not using these materials. This test was administered by the Primary Supervisor.

2. The Vancouver Survey Test in Arithmetic Fundamentals (Form 59), Grade II. This test was given to all pupils in Grade II of Vancouver schools.

3. A survey test based on content taught with Cuisenaire materials. This test was given only to Cuisenaire classes.

Table IV presents the average grade equivalent scores on the arithmetic portion of the Metropolitan Achievement Test, Primary II Battery, Form T, that was administered in June 1959, to all classes in Grade II of those schools that had experimental classes.

TABLE IV: AVERAGE GRADE EQUIVALENT SCORES FOR "AVERAGE ARITHMETIC" (ARITHMETIC FUNDAMENTALS AND ARITHMETIC PROBLEMS) OF THE METROPOLITAN ACHIEVEMENT TEST - PRIMARY II BATTERY - FORM T, JUNE 1959

	Experimental Classes	Other Classes in Gr. II
Class Average	3.9 (N=155)	3.6 (N=311)
Pupils who had Cuisenaire in Grade I	4.0 (N= 80)	3.7 (N= 25)
Pupils who did not have Cuisenaire in Grade I	3.7 (N= 75)	3.6 (N=286)

The city average for pupils taught by the Cuisenaire method was grade 3.9 while that taught by traditional methods was 3.6. Pupils in all classes who had received Cuisenaire instruction in Grade I did better than those who had not had this instruction. Furthermore, pupils who had received Cuisenaire instruction in Grade I, on the average, scored higher than the others in the grade. The pupils who had Cuisenaire instruction in both grades scored 4.0. This may imply that the benefits are cumulative at this level.

The results on the Vancouver Survey Test in Arithmetic Fundamentals are summarized in Table V.

TABLE V: RESULTS ON THE VANCOUVER SURVEY TEST* IN ARITHMETIC FUNDAMENTALS (FORM 59), GRADE II, FOR CUISENAIRE CLASSES AND FOR OTHER GRADE II CLASSES IN FIVE VANCOUVER SCHOOLS, JUNE 1959.

	Experimental Classes	Other Classes in Gr. II
Average	170.8 (N=154)	168.0 (N=321)
Average Score for pupils who were instructed with Cuisenaire materials in Grade I	174.5 (N=79)	178.2 (N=25)
Average Score for pupils who were not instructed with Cuisenaire materials in Grade I	166.9 (N=75)	167.8 (N=296)

* Possible Score 200

The mean score made by pupils in the experimental group was higher than that made by pupils in the other Grade II classes. In both groups, experimental and control, the mean score for those pupils who had had Cuisenaire instruction in Grade I was higher than for those who had not.

In all classes, with one exception, pupils who had been instructed with Cuisenaire materials in Grade I scored above those who had been taught by traditional methods in Grade I.

When one considers the scores for those 104 pupils who were instructed with Cuisenaire materials in Grade I, the higher mean (178.2) for 25 control pupils over that of (174.5) for 79 experimental pupils, is partially explained by the somewhat superior mental ability of this small group.

The results on the special test based on content taught with Cuisenaire materials are summarized in Table VI. Again pupils who were instructed with Cuisenaire materials in Grade I scored above those who had been taught by traditional methods.

TABLE VI: RESULTS ON A TEST BASED ON CONTENT TAUGHT WITH CUISENAIRE MATERIALS, JUNE 1960 (EXPERIMENTAL CLASSES ONLY).

Possible Score	20	
Range of Marks	0-19	
Average Mark	7.6	(N=155)
Average mark for pupils who had Cuisenaire instruction in both Grade I and II	8.2	(N=79)
Average mark for pupils who had Cuisenaire instruction in Grade II only	7.0	(N=76)

Teachers' and Consultants' Views on the Use of Cuisenaire Materials (September 1959)

A questionnaire very similar to one used in Scotland (57) in 1958 was distributed to fifteen teachers and two consultants in Vancouver schools. Their responses reflected a consensus opinion:

1. that by using Cuisenaire materials, teachers obtained better results than they would have achieved in the same time without the materials;

2. that children using Cuisenaire rods tended to be less readily frustrated than formerly;

3. that for a substantial number of pupils, skill in addition, subtraction, and multiplication was more quickly and easily developed by using Cuisenaire materials;

4. that the use of Cuisenaire materials made possible a saving of time in the teaching of primary arithmetic;

5. that it was possible to achieve results at least as good as those attained by traditional methods by the time the children leave Grade II;

6. that working in groups assisted the learning process;

7. that there was no sex difference in rate of learning arithmetic;

8. that, when the time comes, teachers will experience little difficulty in weaning children away from using the materials;

9. that in observing how children work with the rods, teachers were able to gain information that might not be obtained otherwise; and

10. the teachers and pupils enjoyed working with Cuisenaire materials.

Conclusions

1. Children who have been taught with Cuisenaire materials in Grades I and II gain remarkable facility, as shown in the special test, in the complex manipulation of whole numbers and fractions and, at the same time, they make progress in the prescribed course of numberwork that is at least as good as that made by those pupils who are taught by traditional methods. To say the least, Cuisenaire materials appear to be valuable as visual and tactile aids to learning.

2. Within the range of the abilities studied, Cuisenaire materials appear to be no more effective with bright children than with slow children.

3. Both on a standardized test and on a special Cuisenaire test, children who had used these materials for two years surpassed those pupils who had had only one year of this instruction and they, in turn, do better than those who had had none.

4. There is some slight indication that greater benefit accrued from the use of Cuisenaire materials in our Grade I classes than in our Grade II classes.

5. Primary consultants and teachers who have used Cuisenaire materials are enthusiastic about their value.

Recent Developments in Vancouver

In the 1959-60 school year, it was possible to examine the cumulative effects to Grade III of Cuisenaire instruction in two of the original experimental schools.

The Metropolitan Achievement Test, Elementary Battery, Form U, was given in March to all pupils in Grade III. The median grade-equivalent scores in "Average Arithmetic" are summarized in Table VII.

TABLE VII: MEDIAN GRADE-EQUIVALENT SCORES IN "AVERAGE ARITHMETIC", METROPOLITAN ACHIEVEMENT TEST, ELEMENTARY BATTERY, FORM U, GRADE III, VANCOUVER, MARCH 1960.

School	Median in Cuisenaire Class	Median in Traditional Classes	Standards
1	6.0*	4.5	Vancouver Median 4.5
2	5.3**	4.8	Publisher's Norm 3.7

* 6.0 is at the 98th percentile in the city distribution.
** 5.3 is at the 91st percentile in the city distribution.

In the 1959-60 school year the experiments in Grades I and II were repeated in a slightly larger number of classes and the results paralleled those of the previous year.

During the 1960-61 school year, there was at least one Grade I class in each elementary school following the programme of Modern Arithmetic. There were 169 such classes. In addition, there were 22 classes in Grade II and 11 in Grade III on this programme.

In the 1961-62 school year, all classes (191) in Grade I were following the new programme. In addition, almost all (168) of the classes in Grade II and 33 in Grade III were using the coloured rods.

While the Vancouver School Board has been favourably impressed by the benefits that accrue from the use of Cuisenaire rods, it has not been prepared to implement exclusively the material and methodology as recommended in the Cuisenaire publications. The Vancouver programme has retained all that is in the present arithmetic course for the primary grades, including measures, Roman Numerals, Canadian currency, etc. Teachers in Vancouver are continuing to use many other materials and to explore different approaches to mathematics. To this end, the Board has kept in touch with current developments in primary arithmetic in other parts of the world.

Vancouver teachers are following the notes on the use of coloured rods that have been developed in Australia. Ideas have been exchanged with the University of Illinois Arithmetic Project and Vancouver pupils are now experiencing some of the exhilarating adventures into mathematics that are being developed by this study group: number lines (88), frame arithmetic (65, 85), probability (66), manoeuvres on lattices, number sentences, etc, (65). Representatives are serving on provincial and interprovincial arithmetic curriculum committees. Officials are studying the many new programmes of Modern Arithmetic and are keeping in touch with research findings.

The Vancouver School Board is being careful to keep the "New Arithmetic" in perspective (particularly through the Primary Supervisor and Teacher-Consultants), and to maintain a high level of achievement in the fundamentals of arithmetic. Principals have designed "Arithmetic Recall Aids". These are diagnostic exercises that are used systematically in May and September. The Stanford Primary Battery is given in April to pupils in Grade II and the Metropolitan Elementary Battery in March to all pupils in Grade III. Form U of the Metropolitan Battery (see Table VII, above), was given again in 1961. The median in "Average Arithmetic" was a grade-equivalent score of 4.6 (N=5,077). The Vancouver Survey Tests in Arithmetic Fundamentals are given in early June each year to all pupils in Grades II to VI. Since these tests were first instituted in 1955, there has been continuous improvement. On Form 59, given in 1959 and 1961, the results in Grades II and III were as follows:

	Possible	Median 1959	Median 1961
Grade II	200	180.4	187.6
Grade III	184	166.3	171.1

The Vancouver School Board has appointed two teacher consultants to co-ordinate the Modern Arithmetic programme. These people supervise the in-service training of teachers, give demonstration lessons, facilitate the exchange of ideas and materials, and assist with instructional problems.

The Modern Arithmetic programme for the primary grades of Vancouver schools is not yet completely developed. A tentative draft of a curriculum guide for teachers has been prepared. . A committee of principals is presently working on a revision of the arithmetic curriculum for the intermediate grades so that the benefits accruing from the Modern Arithmetic programme at the primary level will be maintained and extended through the higher grades.

The manner in which teachers in Vancouver are integrating Cuisenaire materials with the prescribed programme of primary arithmetic and supplementing it with curriculum developments in modern mathematics, and at all times, stressing understanding, reflects Lindstedt's interpretation of "meaningful arithmetic":

> "As in many educational issues, the optimal principle to follow is not necessarily one specific viewpoint, but a synthesis or combination of several. In the intricate pattern of arithmetic understanding, many inter-woven threads are used: if the woof is made up of concrete manipulative illustrations, and the warp is the application to problems, the emerging design is one of rational, logical development of the underlying fundamental mathematical concepts." (61, p. 2)

Such is the fabric of the primary numberwork programme in Vancouver; its pattern is constantly being enhanced and enriched by the embroidery of imaginative teaching.

Supplemental Notes (May, 1964)

In the 1962-63 school year, all classes in Grades I and II were doing "Modern Arithmetic", and almost all of the Grade III classes were also following this programme.

In the present school year (1963-64), all classes in Grades I, II, and III (except for one class involved in a Departmental experiment) are using coloured rods.

On Form 60 of the Vancouver Survey Tests in Arithmetic Fundamentals, given in 1960 and 1962, the results in Grade II and III were as follows:

	Possible	Median 1960	Median 1962
Grade II	200	183.1	--*
Grade III	184	165.6	167.7

(*This test was not given city-wide because it was considered to be no longer suitable for the new arithmetic programme in Grade II.)

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BOARD OF SCHOOL TRUSTEES
DEPARTMENT OF RESEARCH AND SPECIAL SERVICES
VANCOUVER, B. C.

May 27, 1964

Teachers' Views on the Use of Coloured Rods in Teaching Primary Numberwork

A questionnaire was designed by Drs. D. Karatzinas and T. Renshaw, Department of Education, University of Edinburgh, to obtain the views of practising teachers on the usefulness of the Cuisenaire materials in the teaching of arithmetic. The results of this study were published in the Scottish Educational Journal, September 19th, 1958, and September 26th, 1958.

The same questionnaire, with a few necessary modifications, was distributed in June, 1959, to fifteen teachers and two consultants who have been working with Cuisenaire materials in Vancouver schools. There was one hundred percent response. The replies were summarized in Appendix A of the Cuisenaire report, September 9, 1959.

This questionnaire, modified and extended, was distributed again in May, 1964 to all 518 teachers of primary classes in Vancouver schools. At the time of writing, replies have been received from 409 teachers.

The completed forms were returned unsigned and without any means for identifying the respondent. Furthermore, the teachers were encouraged to respond frankly and to return the completed questionnaire directly to this office if for one reason or another they preferred not to have their comments viewed by the Principal.

A letter to the teacher accompanied the questionnaire explaining the purpose of the survey. As the 1963-64 school year was the first one in which coloured rods were being used in all of the primary classes in Vancouver, it is appropriate and timely to review the reactions of teachers to these materials. The letter clearly stated that the questionnaire was not intended to be used in any way for the rating of teachers. Another letter was addressed to the Principals asking that they encourage teachers to complete the questionnaire and to return it promptly. One subsequent request was made to the schools for the return of outstanding questionnaires.

In seeking to determine the reason for the non-return of some questionnaires, the writer discovered that

(a) some teachers of "split" Grade 3 - 4 classes failed to respond because they did not consider that they were teaching a true "primary" class, (particularly, at this time of year);

(b) others were substitute teachers who felt that it was not their prerogative to respond; and

(c) still others were beginning (probationary) teachers who felt that they had not had sufficient experience with the materials to make valid comments.

Returns have been received from 409 teachers, approximately 79% of the number to whom the questionnaire was addressed. Five of the questionnaires that arrived too late and another that was incomplete have not been included in the tabulations below.

The length of time that the respondents had been using coloured rods ranged from four months to eight years, the 'typical' teacher having almost three years experience with them. (see Table 1.)

Table 1. Number of Years Experience with Coloured Rods

Experience (Years)	½	1	2	3	4	5	6	7	8	Not ind.	Total
# of Teachers	8	83	105	118	54	94	9	1	2	8	402
%age	2.0	20.6	26.1	29.4	13.4	3.5	2.2	0.2	0.5	2.0	99.9%

The distribution of respondents according to the grades taught is presented in Table 2.

Table 2. Grades at which Respondents are Teaching

	Number	%age
Grade 1	145	36.1
Grade 2	114	28.4
Grade 3	109	27.1
Grades 1, 2, & 3	1	0.2
Grades 1 & 2	14	3.5
Grades 2 & 3	19	4.7
	402	100.0%

The replies to the questions are summarized below and a few of the most significant comments are included.

Slightly more than 2/3 of the respondents felt that by using the rods they had achieved better results than they would have without them. This proportion was remarkably consistent at all grade levels. Approximately one teacher in ten felt that she had not achieved better results with the rods than without them.

Question 1. Do you consider that by using the rods you have had better results than you might have achieved in the same prescribed time without the materials?

Reply	Yes	No	Not sure	No answer	Total
Number	269	42	63	28	402
Percentage	67%	10%	16%	7%	100%

"The related objects (rods) give a far greater visual conception of number than the unrelated."
"Excellent results are achieved in understanding numbers, value, adding, subtracting, multiplying and dividing, especially with brighter students."
"So much to cover, too little time for "drill" needed by slow students."
"The work accomplished is not a preparation for Seeing Through Arithmetic in Grade IV.

Question 2. Do you think that with the aid of the rods children tend to be less readily frustrated than formerly?

Reply	Yes	No	Not sure	No answer	Total
Number	269	60	61	12	402
Percentage	67%	15%	15%	3%	100%

"The rods tend to make the number facts very clear and concrete. These are presented in so many different ways that children are always very interested.
"Bright children are less frustrated and find the challenge stimulating but slow children tend to be more frustrated with the difficulty of the programme of work, especially with fractions."
"Pupils can always "prove", "check" their work."

Question 3. Schonell in his book Diagnosis and Remedial Teaching in Arithmetic on page 12 states "Most of the Difficulty in arithmetic arises because we hurry pupils too much in the early stages". Do you consider that with the aid of the rods it is possible to proceed firmly and quickly during the early stages?

Reply	Yes	No	Not sure	No answer	Total
Number	173	110	75	44	402
Percentage	43%	27%	19%	11%	100%

"Yes, with bright children. No, with slow children."
"Firmly yes, quickly no; too much speed not wise. Children need time to comprehend."
"We are trying to teach too much in a year, especially to slower pupils."

Question 4. What effect has the pupils' "free play" with the rods in kindergarten had on the rate of learning during the early stages?

Reply	Has helped considerably	No effect	Slight benefit	No answer	Total
Number	59	12	70	19	160
Percentage	37%	7%	44%	12%	100%

"It would help considerably if the children took all the pre-number steps in Kindergarten. An awareness of the number concepts could be developed which would be an excellent foundation for Grade 1 work."
"Has helped considerably with brighter children. Slight benefit with slower children."

Question 5 (a) Looking ahead, would you say that for a substantial number of pupils skill in addition may be more quickly and more easily developed using the material?

Reply	Yes	No	Not sure	No answer	Total
Number	337	48		17	402
Percentage	84%	12%		4%	100%

"Understanding is definitely increased."
"It is a good aid but the usual drill is necessary, especially for slower children."

Question 5 (b) Looking ahead, would you say that for a substantial number of pupils skill in subtraction may be more quickly and more easily developed using the material?

Reply	Yes	No	Not sure	No answer	Total
Number	312	68		22	402
Percentage	78%	17%		5%	100%

"A very good aid here. The children quickly see the separations."
"Subtraction is harder. Children must learn how to place rods."

Question 5 (c) Looking ahead, would you say that for a substantial number of pupils skill in multiplication may be more quickly and more easily developed using the material?

Reply	Yes	No	Not sure	No answer	Total
Number	355	31		16	402
Percentage	88%	8%		4%	100%

"Rods facilitate understanding."
"Skills quickly developed by bright and average."

Question 5 (d) Looking ahead, would you say that for a substantial number of pupils skill in division may be more quickly and more easily developed using the material?

Reply	Yes	No	Not sure	No answer	Total
Number	324	28		50	402
Percentage	81%	7%		12%	100%

"I sometimes wonder how we taught multiplication and division without the rods."
"Rods alone, no."

Question 6. Do you think that difficulty may be experienced in weaning children away from using the material?

Reply	Yes	No	Not sure	No answer	Total
Number	154	203		45	402
Percentage	38%	51%		11%	100%

"When children are secure they take pride in being able to do problems without the rods so automatically discard them as their facility with numbers increases."
"Very slow children should not be "weaned" too early."
"Slow children difficult to "wean"."
"Never had any such difficulty."

Question 7. Do you consider that the use of the rods can make possible a saving of time in the teaching of primary arithmetic?

Reply	Yes	No	Not sure	No answer	Total
Number	167	144	76	15	402
Percentage	41%	36%	19%	4%	100%

"No, but children understand what they are doing, as they never did before. They reach for new relations of numbers and experiment."
"Why do we have to save time? Where is the fire? Give the children the gift of time to enjoy the learning process."
"Yes, absolutely, and increases the range of material taught."

Question 8. With coloured rods, do you think that it may be possible to achieve results at least as good as those attained by traditional methods by the time children leave Grade II?

Reply	Yes	No	Not sure	No answer	Total
Number	294	20	63	25	402
Percentage	73%	5%	16%	6%	100%

"Better understanding of wider fields but not greater speed at first."
"Drill needed as supplement."

Question 9. In your experience, do children taught with coloured rods score as well on standardized tests of basic number facts as those taught by traditional methods?

Reply	Yes	No	Not sure	No answer	Total
Number	144	62	156	40	402
Percentage	36%	15%	39%	10%	100%

"Some children are not as fast but they understand arithmetic better and become more adept at reasoning."
"No, because there is so much emphasis on fractions which are not tested on standardized tests at this level."
"Some children are not as fast but they understand arithmetic better."
"More adept at reasoning."

Question 10 (a) How much time do you think is desirable to allow the children at the outset for unaided exploration (free play) with the materials? (Please state briefly how many periods or parts of periods you think should be set aside for this purpose.)

Responses ranged from none to 20 periods or to 30 part periods. The 'typical' teacher felt that about five periods or ten part periods would be sufficient. A small number of teachers of Grade I classes felt that no time allowance need to be made for unaided exploration if the pupils have had free play in kindergarten.

Question 10 (b) Is it generally better to give time for exploration at the end rather than the beginning of a period?

Reply	End	Beginning	Both	Neither	Varies	Total
Number	193	126	9	3	14	345
Percentage	56%	36%	3%	1%	4%	100%

"Best exploring is done when children are doing it for extra work in free time."
"To understand new concepts "beginning" is preferred. To extend relationships after understanding the "end" is preferred."
"If class is divided into groups, at beginning of lesson with each group."

Question 11. Please give examples of one or two of the more striking "discoveries" the children have made for themselves.

The children have made many discoveries but not ones that could be considered truly "striking". They have learned quickly by themselves that the rods may be interchanged in a variety of ways, proving that they understand thoroughly the principles involved.

For example:
(a) The relationship between fractions and factors--when they found that 7 would fit into 21 three times, they could see that 1/3 of 21 = 7.

(b) Discovering that if $4 \times 4 = 16$,

then $\frac{1}{4} \times 16 = 4$; $4\overline{)16}^{\,4}$; 4 is a factor of 16.

(c) That $2 = 2 \times 1 = 1/2 \times 4$, $1/3 \times 6$, $1/4 \times 8$, etc.

(d) $(4 \times 5) + 2 = (2 \times 10) + (2 \times 1)$.

Question 12. (a) Did you teach the fact that rods of the same colour are also of the same length or did you wait until the children discovered this fact for themselves?

Reply	Taught	Waited	Both	Total
Number	24	54	25	103
Percentage	23%	53%	24%	100%

"Led them to discover this fact; directed the discovery."
"Some knew this from kindergarten, bright students saw it very easily for themselves."
"Children seldom forget things learned by their own experience."
"Taught because not enough time to wait for slow students. It is a basic principle and so should be realized as soon as possible."

Question 12 (b) Is anything to be gained by waiting until the children have made this discovery for themselves?

While 54 teachers indicated (in item 12(a)) that they waited for the children to make this discovery themselves, only 20 said that there was an advantage to be gained by waiting. At the same time 42 teachers claimed that there was nothing to be gained by waiting. (The writer is inclined to think that this question was not understood.)

Question 13. How long does it take the children to learn to link colour and length (the white rod taken as a unit)?

	Range of Answer	Median
Beginners	1 lesson to 6 months	4 weeks
"Duller" children	3 lessons to 6 months	4 weeks
"Brighter" children	1 lesson to 2 months	1 week

Question 14 (a) Does working in groups assist "the learning process"?

90% of the 312 respondents to this item thought this to be so.

Question 14 (b) What is the optimum size of group?

Range of answers 3 to 20. The median of these was 10.
33% of the 335 replies gave 10 as the optimum number while 74% chose 10 to 15 as ideal.
8% thought it important to have small groups of 4 to 6 for slow students.

Question 14 (c) What is the best sort of grouping (e.g., sexes separate, dull children with bright children, etc.)?

88% of the 318 replies indicated that homogeneous grouping was preferred.

Question 15 (a) Is there any evidence of a different rate of learning between boys and girls?

Reply	Yes	No	Possibly	Total
Number	78	209	10	297
Percentage	26%	71%	3%	100%

Question 15 (b) If so, which way?

Reply	Boys faster	Girls faster	Equal	Total
Number	50	45	100	195
Percentage	26%	23%	51%	100%

Question 15 (c) Does the material appeal more to boys than to girls?

Reply	Boys	Girls	Equal	Not sure	Total
Number	78	16	194	7	295
Percentage	25%	7%	66%	2%	100%

Question 16 (a) Have blocks and other manipulative materials been dispensed with?

The 363 respondents answered as follows:
Yes - 53%, No - 32%, Partly - 15%.

Question 16 (b) If not, what materials other than rods do you use?

Of the 275 teachers who replied,
16% thought pegs, sticks, straws useful
16% chose blocks and other classroom equipment
9% money
8% liked flannel boards
8% favoured flashcards
7% used number charts.

Some stated that they used clocks, quarts, pints, and egg cartons but considered these as aids separate from Cuisenaire.

Others teach a lesson with rods, then give a problem relating this lesson to everyday situations but don't use manipulative material for actual teaching.

Question 16 (c) What are the resulting advantages?

"Some children learn more quickly in one way, others in another."
"Better understanding if using many materials."
"They help slower children.

Question 16 (d) What are the resulting disadvantages?

"Confusion if using many materials."
"Children can not visualize the answer as they can with rods which do a better job."

"Time consuming. More material necessary. Less compact."
"Children see other ways of measuring."

Question 17. What "crutches" do you allow?

Of the 257 replies:

45% allowed the writing of partial answers above that portion of the question. For example:

$$(3 \overset{6}{\times} 2) + 4 = 10$$

38% allowed the use of rods especially for corrections or when learning a new concept but not for tests. Others use rods in this way but do not consider them a crutch.

Question 18. In observing a child working with the rods, are you able to gain information which might not be obtained otherwise?

86% of 297 respondents thought that they did gain information through observation.

"Personality characteristics such as perseverance, ingenuity, originality, and minipulative control."
"Able to see if children understand questions and processes involved. Can diagnose difficulties earlier than with traditional methods."
"Yes, especially: judgment of idstance, recognition of colours, sense of balance."

Question 19. When did you begin (or do you propose to begin) to teach fractions?

The median month chosen by 112 teachers of Grade I for beginning fractions was February.
8 other teachers "taught fractions along with numbers",
12 taught it "when the children were ready",
6 "did not teach them at all".

Question 20. How are you proposing to teach the concept of zero?

A majority of the Grade I teachers simply teach that zero means nothing. They teach it with rods and objects. For example:

(a) If we have nothing and we take nothing 4 times we still have nothing.
(b) $0 + 5 = 5$, $0 + \boxed{5} = 5$, $\boxed{5} + 0 = 5$

Is the 5 any bigger?

No, 5 + 0 then = 5

(c) 0 was "no rod", so it cannot change a problem.

Question 21. Do you foresee any difficulties that use of the material may give rise to later?

Most of the respondents foresaw no difficulties, although a few thought there might be inability to do without rods later.

Question 22. Based on your present experience, how far through the grades do you consider that the use of the rods should be continued?

Consensus of opinion was that the use of rods should continue through Grade III. Range went from Grade I to Grade XII.

Question 23 (a) Did you enjoy teaching all four processes (+ - x ÷) at once when studying a number?

Major portion of teachers said yes.

Question 23 (b) Why?

Doing so gives the children a more thorough understanding of each number studied. The few teachers who answered no to part (a) felt that it was difficult for slow children to grasp all processes at once.

Question 24. Has the content of the year's work, as outlined in Seeing Through Arithmetic, Book 3, and Arithmetic With Numbers in Colour, been: (Too much / Too little / Just right). Please indicate the ability of your class. (Fast group / Average group / Slow group).

Group	No.	"Too Much"		"Just Right"		"Too Little"	
Fast	8	2	25%	3	37.5%	3	37.5%
Average	43	26	60%	17	40%	0	0%
Slow	19	14	74%	3	16%	2	10%
Totals	70	42	60%	23	33%	5	7%

"Too much for average or slow groups."
"Difference between rods and the old method is the difference between 'understanding' and 'memory'."
"S.T.A. does not progress fast enough; too much time on pictures, rods do this more quickly."

Question 25 (a) With what success have you used both the S.T.A. text and the Number in Colour manuals at once?

Together successfully	4
Fair success	2
No success	5
Used S.T.A. alone	4
Used N.I.C. mostly	11

Question 25 (b) Do the points of view in each merge or diverge?

Diverge	24
Merge	14
Merge, in the end	6
Complement each other	4

Question 25 (c) Please comment.

Both are helpful	2
Cannot use S.T.A. and Cuisinaire with justice to both	8
S.T.A. is too easy	8

Dislike S.T.A., too big a book 9
S.T.A. problems are good 12
Would like a Cuisenaire textbook 2

Question 26. Have your pupils appeared to enjoy working with these materials?

97% of the 239 teachers replying to this question said yes.

Question 27. Have you enjoyed instructing with coloured rods?

95% of the 240 teachers who answered said they had enjoyed instructing with the rods.

Question 28. What is your opinion of the Teachers' Manuals? (If you are using the newly revised manuals, 1963, do you consider these of greater help?)

Teachers of all three grades say that Teachers' Manuals are "very helpful". A somewhat smaller group felt the manuals were only a general guide, useful for planning, but inadequate by themselves. Some said, "Consultant has been of more help."

Of 27 teachers using the 1963 manual 25 considered this of greater help.

Question 29. Please comment frankly on your difficulties, and the children's difficulties, at various points in the past year's work.

Teachers' Difficulties

Of the 108 teachers of all grades who answered 65.7% thought there was too much content and not enough time. 7% listed lack of teacher experience as a problem.

Children's Difficulties

172 teachers answered this question. Of these:

37.7% thought fractions were unnecessary, especially for slow Grade I and Grade II's.
13.9% stated that children had difficulty with transition from concrete to abstract.
12.7% felt that more drill was needed.

Question 30. What suggestions have you to make in regard to In-Service Training of teachers?

Many teachers of all grades thought there should be a crash programme (similar to B.C.T.F. Summer Course) at the beginning of the school year or before school started. Numerous others thought a meeting should be held once a month, particularly for new teachers. Other suggestions included:

Taking more advantage of Consultants' help.
Having practical demonstrations with rods and pupils.
Getting an outline of what to teach and when.

Question 31. Will you please give any other information about your use of the material that you think may be of interest.

52 teachers replied. The comments included:
"Orange and brown rods are close in colour."
"The "4" rod should be called pink instead of crimson which is unfamiliar to Grade 2."
"Did mosaic drawing of rods and coloured them."
"Long trays to hold rods. Keeps patterns from being knocked apart by small hands."
"Must be used as a new method, not an aid to the old."
"Large match boxes are handy -- the 10 rods just fit."
"Use rods for play time activity."